(12) UK Patent Application (19) GB (11) 2 115 490 A

(21) Application No 8205620
(22) Date of filing 25 Feb 1982
(43) Application published
7 Sep 1983
(51) INT CL³
F01C 3/06
(52) Domestic classification
F1F 1C D
(56) Documents cited
GB 1458459
GB 1448808
GB 0495064
GB 0462054
(58) Field of search
F1F
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(54) Rotary positive-displacement fluid-machines

(57) A machine of the nutating-disc type that may be adapted for use as an engine or a pump comprises a piston 16 mounted obliquely on a rotary shaft 34 so that relative to the shaft it can revolve about its own axis t_2 while the shaft turns about its axis t_1. Slotted elements 21 in the piston are disposed radially thereof and engage slidingly with radial blades 28 fixed in a housing structure 2, which has conic inner surfaces 9 and is either fixed or rotates with the shaft. Ports (29), Fig. 2 (not shown), for the working fluid may be formed in the conic surfaces. Power-transmitting gear-teeth 30 may be attached to the housing structure. When the housing structure is fixed the piston revolves about its axis as it rotates with the shaft and nutates in the housing structure but is fixed relative to the housing structure when the latter rotates with the shaft. Modifications are described with reference to Figs. 4 to 7 (not shown), one modification being such that there are two co-operating pistons in a common housing structure (Fig. 7).

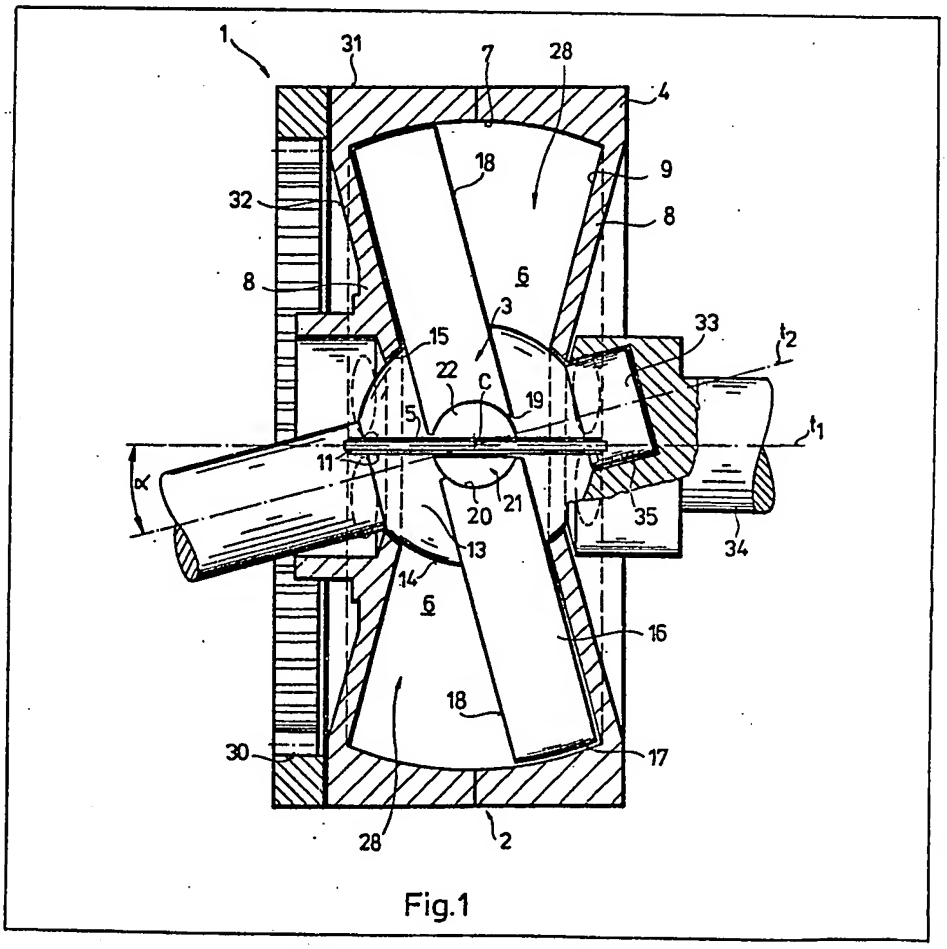

Fig.1

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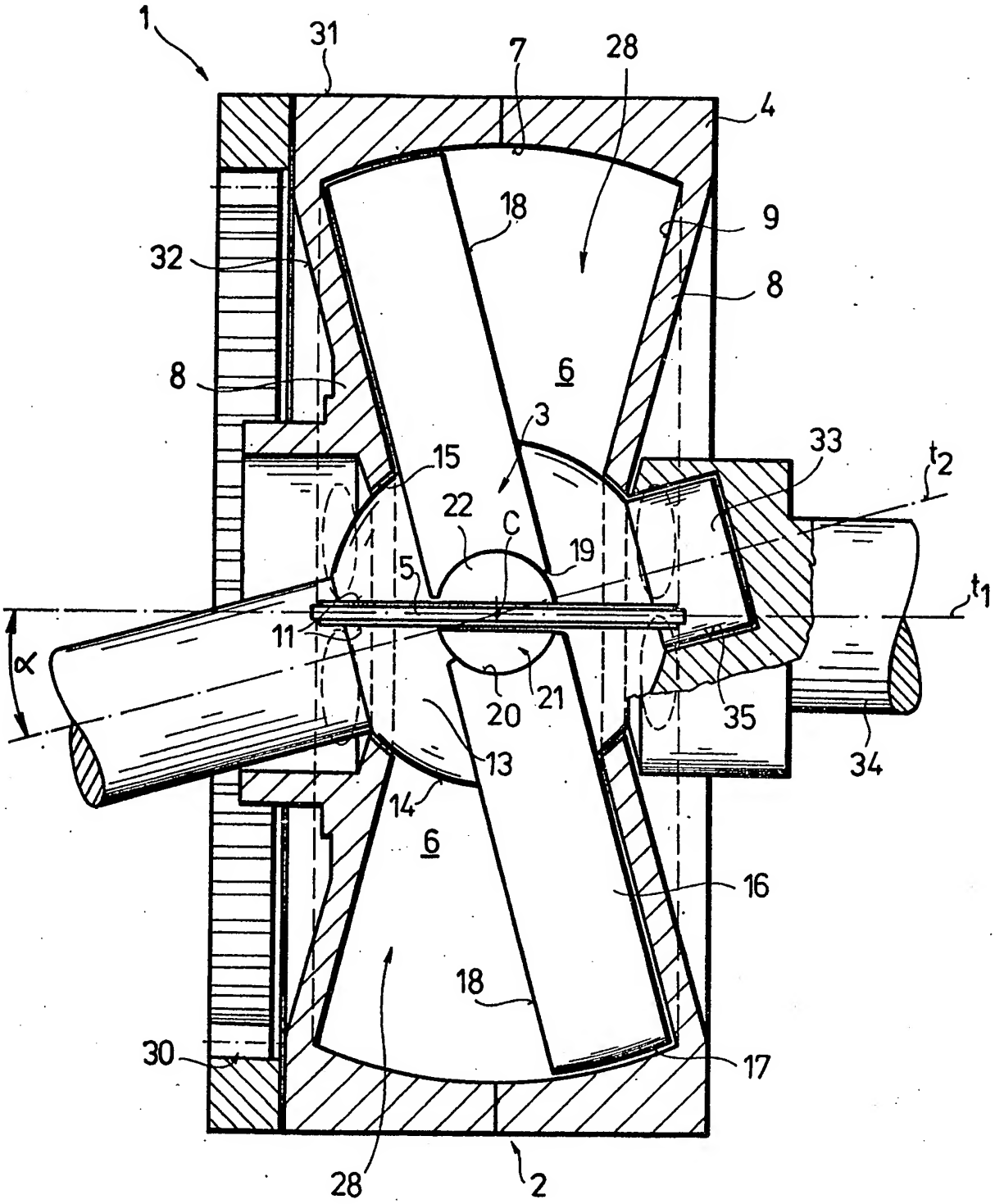
The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.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31
7
28
4
18
9
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6
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33
t_2
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C
19
5
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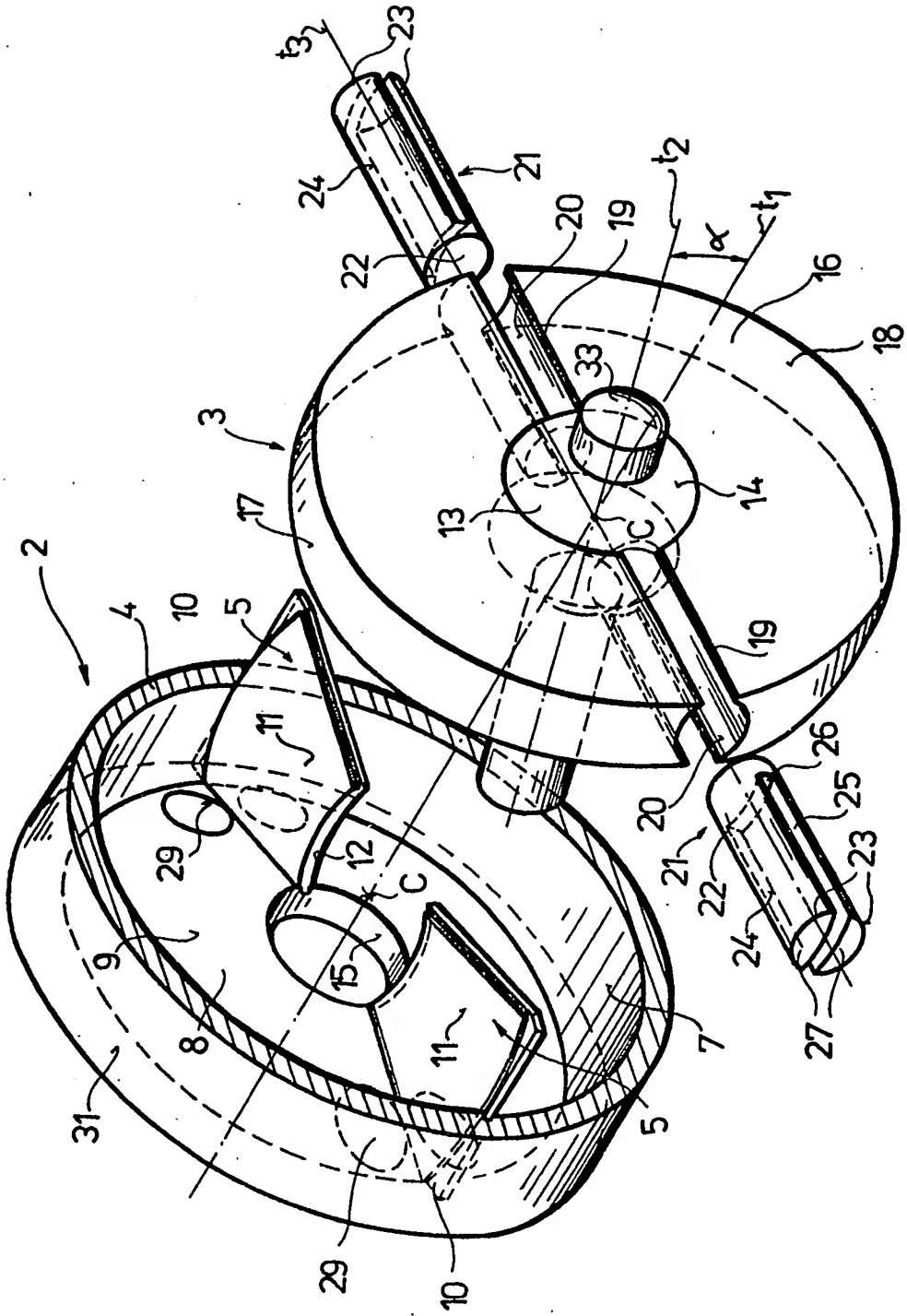
Fig.1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31
33
C
α
t1
t2
t3

Fig.2

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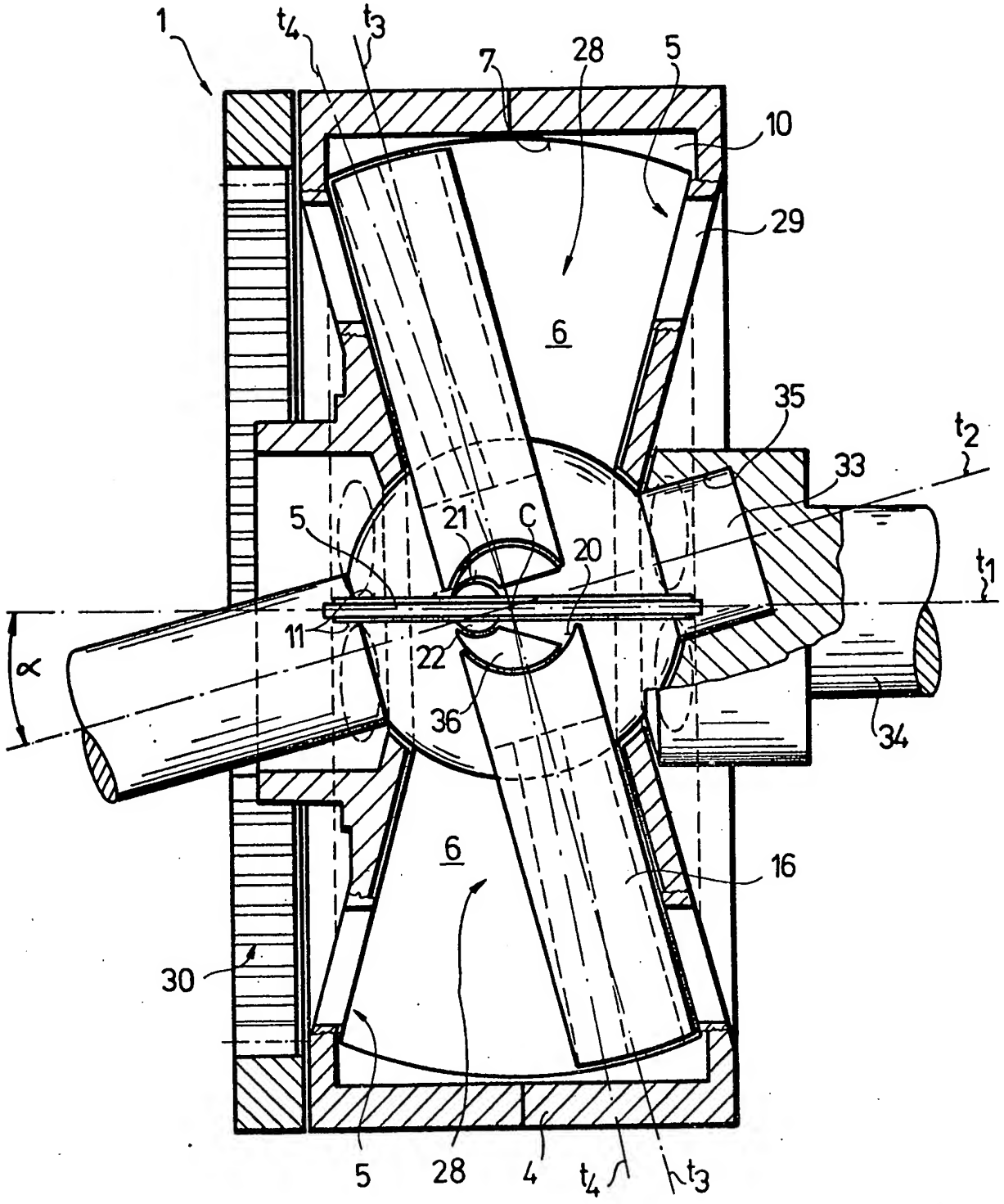

Fig. 3

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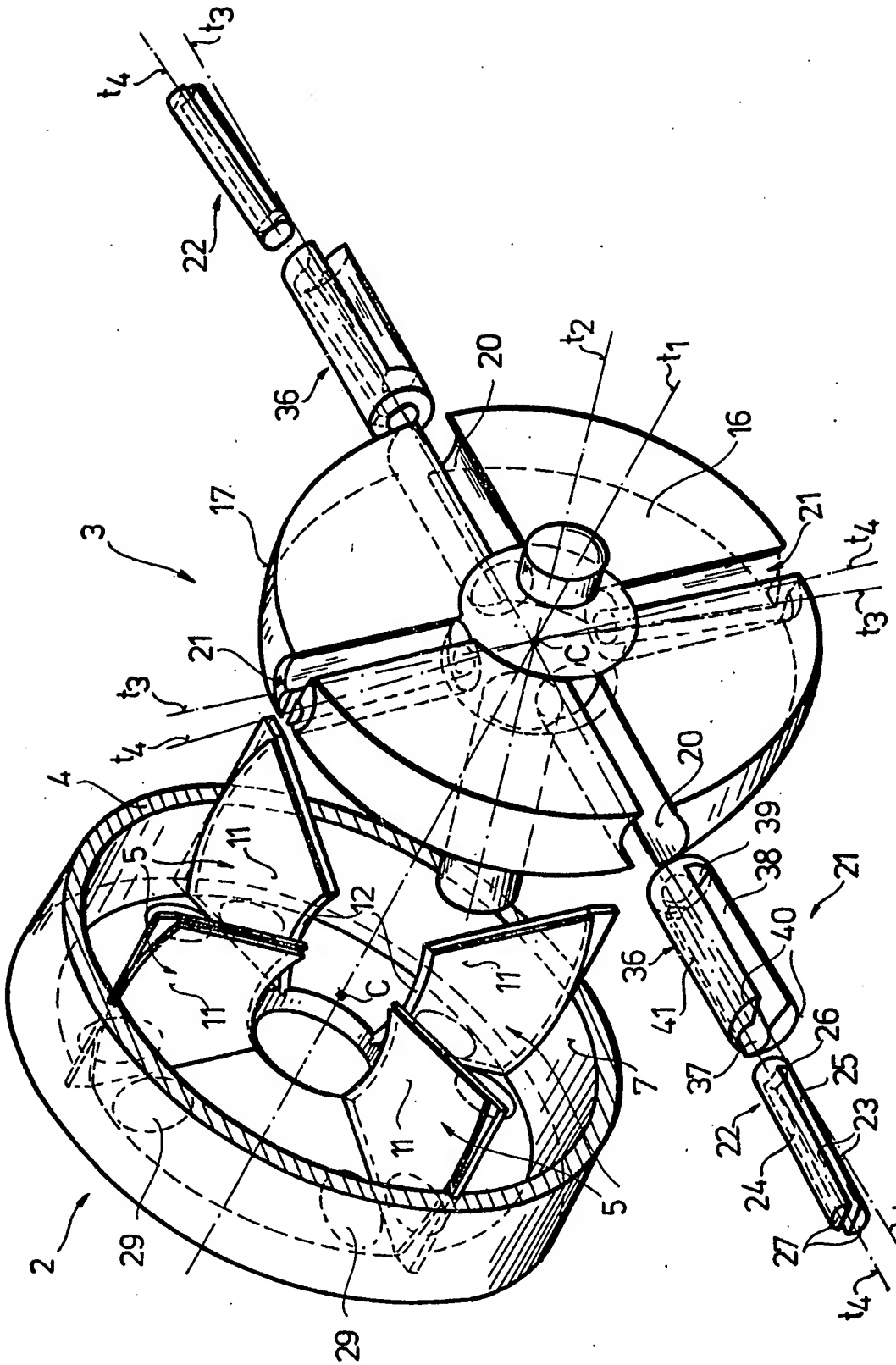

Fig. 4

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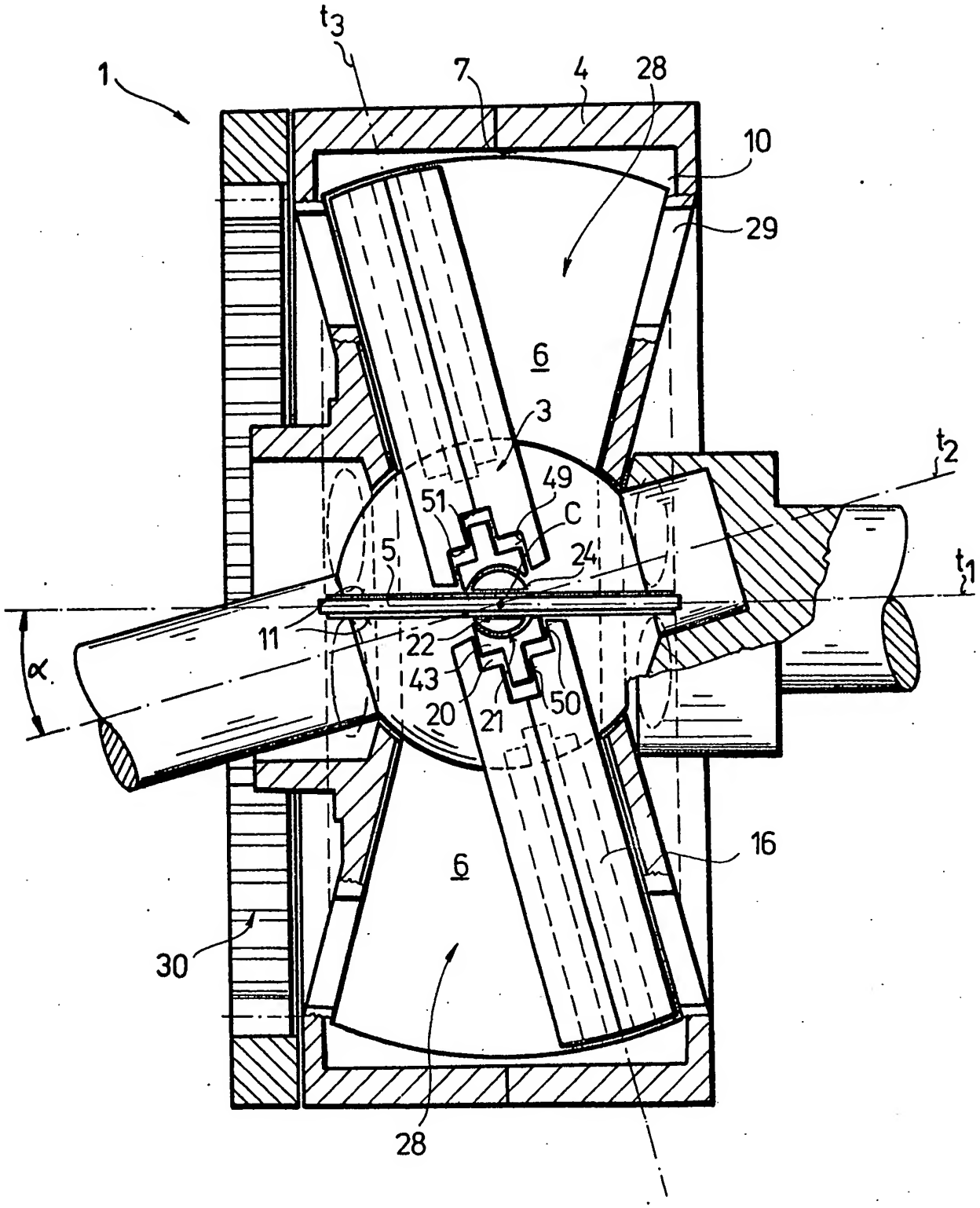

Fig. 5

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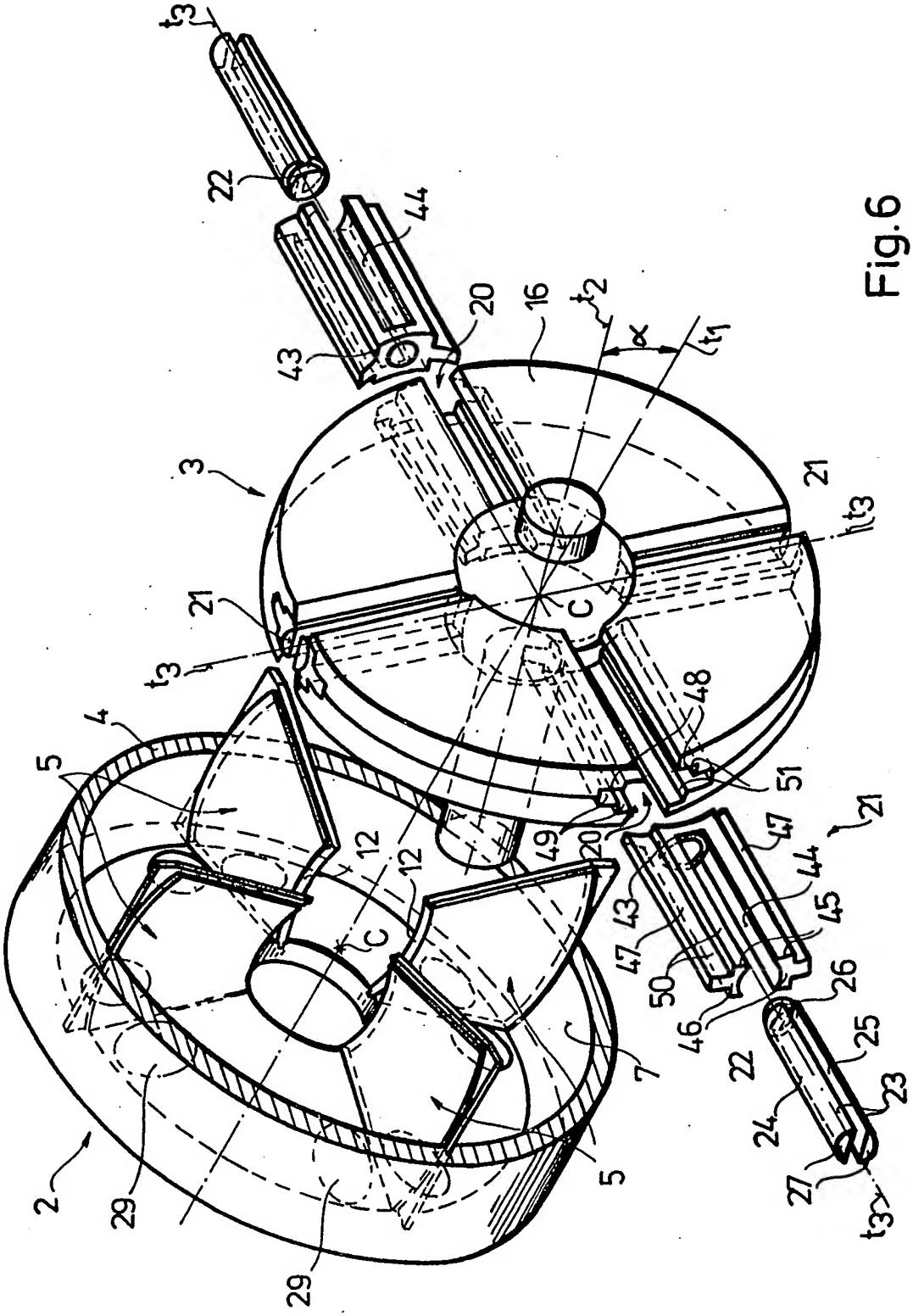

Fig.6

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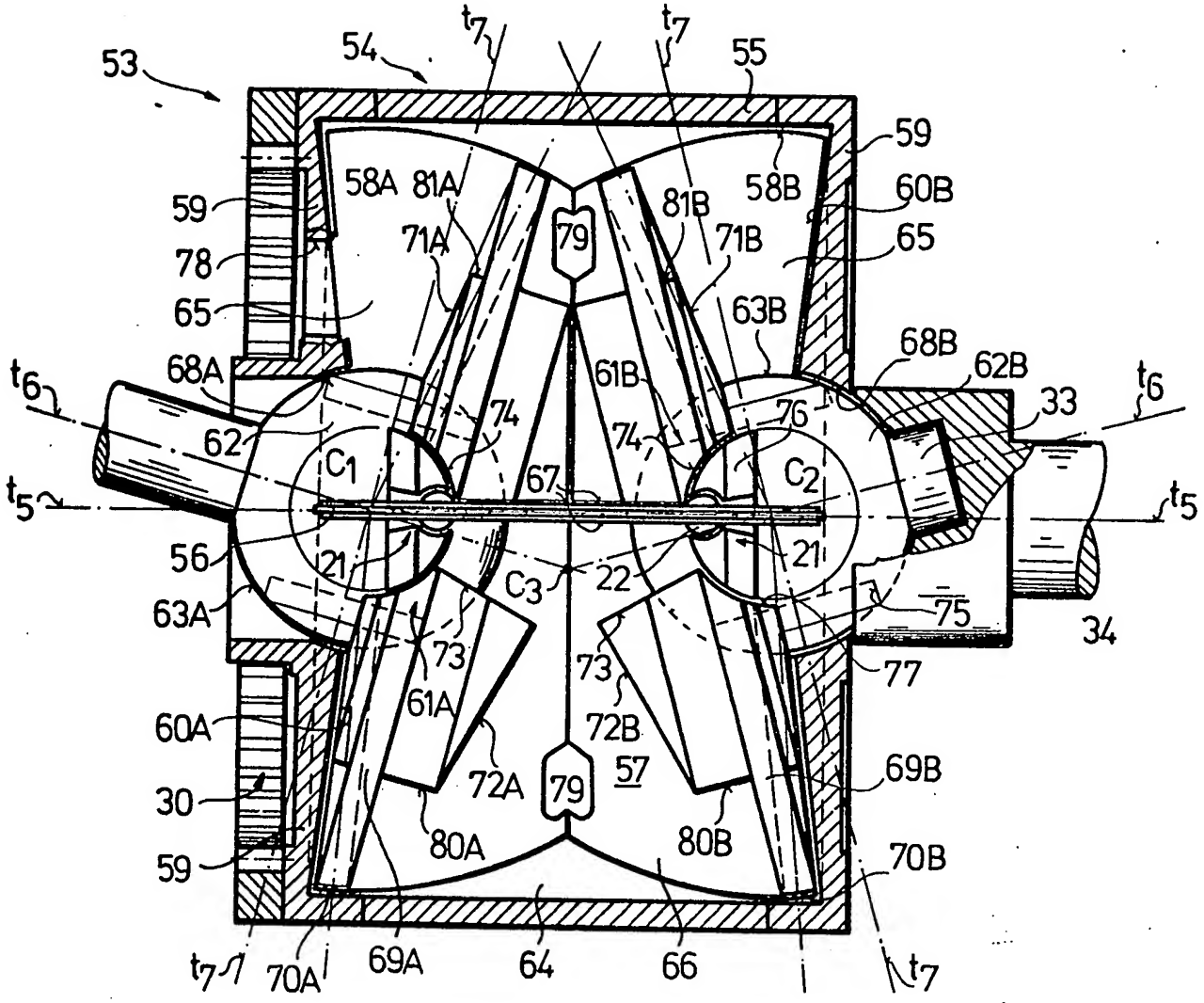

Fig.7

SPECIFICATION

Ball piston construction for machines

The invention relates to ball piston construction for machines e.g. power machines, that is engines or pumps, with two axes of rotation intersecting each other at an angle variable between 0° and approximately 90°; the total inner volume of the ball piston construction is divided into compartments of varying number and compression according to the partition with the aid of blades and motion equalising devices, and the friction and relative displacement of the co-acting devices are minimal.

There are pumps and engines with ball piston, in which the axes of the ball pistons driven in forced coupling intersect each other and the interposed third oscillating piston divides the interior of the pump house confined with spherical surface into compartments. Such solution is described for instance in the US—PS 3 816 038, 3 816 039 and 3 877 850. In these constructions the number of compartments is limited, the elements moving, turning in relation to each other are spherical and cylindrical ensuring relatively favourable machining possibility. On the other hand extraordinary machining and sealing problems appear in the solutions related to slant-axial engines and pumps (GB—PS 1 431 261).

In a further similar solution — described in the FR—PS 2 230 855 — owing to the adverse balance of forces high friction forces arise on the rotary partition walls separating the compartments.

The invention is aimed at the realization of machine family operating at uniform rate with low internal friction, having optional number of compartments by using motion form based on the known slant-axial solutions, which consists of easily producible parts effectively sealable and thus it can be widely used. Further objective was the realization of such solution, when the compression ratio of the compartments is optionally variable.

The objective is attained with a ball piston construction according to the invention, in which the interior of the housing is divided by blades into optional member of compartments, spherically embedded wobbling (swinging) piston is arranged in the housing structure, the piston disc of which divides the interior into compartments of variable volume, and the blades fixed in the housing structure are surrounded with sealed motion equalizing devices fixed in the piston disc.

The invention is a ball piston construction for machines, e.g. engines or pumps, with elements of wobbling motion confining the compartments, provided with medium carrying channels, one of the elements is formed as housing structure, the other one as piston, the interior of the housing of the housing structure is radially arranged being divided into compartments by fixed blades, the interior of the housing is confined by spherical segment-shaped inner faces — the centre of which is the centre of the housing at the same time — and by such lateral face which is a surface of revolution uniaxial with the said inner face, spherical segment-shaped nest is in the side of the housing the centres of both being the same, the side of the blade confining the compartments is such surface of revolution the axis of which is perpendicular to the axis of the housing and to the central plane of the blade, the inner face of the blade is spherical segment fitted and sealed to the superficies of the piston core, the housing has external power transmitting means, the superficies of the piston core fitted and sealed to the spherical segment surface of the nest in the side of the housing, being a spherical segment the centre of which is identical with that of the housing and has power transmitting means for external connection, the piston has piston disc the superficies of which is spherical segment the centre of which is identical with that of the housing, the lateral faces confining the compartments are surfaces of revolution uniaxial with the piston, the constituent of which is common with that of the lateral faces of the housing, the piston disc has a radial slot receiving the blade, in which motion equalizing device is fitted and sealed rotatably in the nest, the inner faces are fitted and sealed to the lateral faces and inner face of the blade as identical geometrical surfaces, the front faces of the fork shanks are fitted and sealed to the inner face of the housing, furthermore at least one the housing and piston cores has power transmitting means formed as motion transmission at the same time.

The construction according to the invention can have more than two blades, the rotary fork of the motion equalizing device can be arranged in excentric fork, the superficies of the shanks of the excentric fork are fitted into the nest of the slot of the piston disc, the nest is formed by the surface of a body of revolution, axis of the next passes through the centre of the housing, the front face of the fork shanks is fitted and sealed to the inner face of the housing, being a spherical surface having identical centre with the housing, and the axis of the nest fitted to the superficies of the rotary fork shanks intersects the axis of the nest arranged in the excentric fork in the centre of the housing.

In the construction according to the invention suitably with more than two blades, the rotary fork of the motion equalizing device can be arranged in flat fork, the shanks of which have outer guide ribs fitted and sealed into the grooves of the nest of the piston disc having suitable flat lateral faces perpendicular to the axis of the piston disc as to allow its rotation around the axis of the piston disc, the front face of the fork shanks is fitted and sealed to the inner face of the housing as spherical surface having identical centre with that of the housing.

In a twin-pistoned construction according to the invention the spherical segment-shaped superficies confining the interior of the housing consists of two spherical segment surfaces suitably with identical diameter the distance between the centres of which is shorter than the

length of the diameter, and the superficies of each piston disc is in contact with the two spherical segment-shaped superficies. The outer lateral faces of the pistons have conical surfaces of identical bending angle tangential to the plane of truncation of the spherical segment-shaped inner faces of the housing.

The spherical surfaces are theoretical confining surfaces. These are regarded as the surfaces of each element even if they are lightened for instance with parts as body of revolution. The housing and the piston may overstep the limit of the theoretically contacting surface, provided that such cavity is formed on the corresponding contacting surface which receives the profile protruding from one of them and allows the relative displacement arising from the wobbling motion. Such suitable construction form may be for instance when the lateral faces of the piston disc and housing are engaged bevel gear surfaces. Assuming maximum angle between the axes of the housing and piston, the inner faces of the housing and the corresponding lateral faces of the piston disc contact each other in the contacting constituent. If the surfaces at the contacting constituent continuously prevent the flow of medium, then a construction with sealed constituent is brought about. If the flow-through is made possible e.g. with lightening the inner lateral faces of the housing by shaping it as body of revolution, then a construction form with transfer hole will be brought about.

These two alternatives impose different requirements on the formation of the medium carrying channels and flow control elements. In case of construction with transfer hole the requirements of the outlet and inlet holes and control elements are the same as for other machines of limited spatial displacement. In case of construction with sealed constituent, the contacting constituent rolling down on the wall of the compartment — on the inner lateral faces of the housing — divides the space of the compartment into two sectors. At such construction each medium carrying channel has an inlet hole in the vicinity of the blades which holes are ordered to each compartment sector.

The ball pistoned machine according to the invention can be operated in three operation modes, where the relative (mutually) movement of the housing and piston is "wobbling" motion in every case.

In wobbling operation mode the housing is fixed through its power transmission means, the power transmission means of the piston is motion transmission at the same time, which rotates the shaft of the piston around conical superficies (in pump and compressor operation), or which is forced to rotate by the shaft of the piston rotating on the conical superficies (in engine and hydro-engine operation).

In rotating operation mode the motion transmission means of the piston is fixed, and the piston embedded in the motion transmission means rotates around its axis together with the housing. The power transmission means of the housing is formed as a motion transmission at the same time which drives the housing (in pump operation) or which is forced to rotate by the housing (in engine, hydro-motor operation).

In the third combined operation mode the power transmission means of the housing and piston are formed as motion transmission at the same time, being in forced driving coupling.

In the above three different operation modes the conditions and possibilities of the construction of the medium carrying channels and flow control elements vary.

In wobbling operation mode the medium carrying channels and the openings leading into the compartments can be most favourably formed in the stationary housing.

In rotating operation mode the medium carrying channels are formed most suitably in the stationary element incorporating the rotary housing, to which the outer surface of revolution of the housing is fitted and sealed and the openings of the compartments perform the task of control as well.

In the combined operation mode the conditions of forming the medium carrying channels are similar to those existing in the rotating operation mode.

Brief Description of the Drawings

The invention is described in detail with the aid of drawings by way of four examples, in which:

Figure 1: axial section of the first embodiment of ball piston construction according to the invention,

Figure 2: isometric (axonometric) view of the elements of the construction according to Figure 1,

Figure 3: axial section of the second embodiment,

Figure 4: isometric view of the elements of the construction according to Figure 3,

Figure 5: axial section of the third embodiment,

Figure 6: isometric view of the elements of the construction according to Figure 6,

Figure 7: axial section of the fourth embodiment of the invention.

Description of the Preferred Embodiments

In the first example shown in Figures 1 and 2, one of the wobbling elements of a ball pistoned construction 1, e.g. power machine with sealed constituent is formed by a housing structure 2, the other one by a piston 3. The housing structure 2 has a housing 4 and blades 5 fixed in the housing 4. Interior 6 of the housing 4 is confined by spherical segment-shaped inner faces 7 and inner lateral faces 9 of sides 8. Centre C and axis t_1 of the spherical segment-shaped inner faces 7 form the centre and axis of the housing 4 as well. The inner lateral faces 9 are surfaces of revolution formed by constituent rotated around axis t_1, in this example being conical surfaces. The constituent may be optional curve, provided that it is contacted or intersected in one point only by an

arc having common centre C with the housing 4.

The blades 5 are fitted and sealed to the inner faces 7 and inner lateral faces 9, and are radially arranged in grooves 10 of the housing 4 (Figure 2). Lateral faces 11 of the blades 5 may be surfaces of revolution the axis of which is perpendicular to the axis of housing 4 and to the medium plane of the blade 5, but they are flat surfaces in this embodiment. An inner end face 12 of the blade 5 is spherical segment-shaped surface fitted and sealed to a spherical segment-shaped superficies 14 of a piston core 13 of the piston 3. The superficies 14 of the piston core 13 is fitted and sealed in a spherical segment-shaped nest 15 formed in the sides 8 of the housing 4, the centre and axis of which are common with centre C and axis t_1 of the housing 4.

The piston core 13 of the piston 3 forms a single piece with a piston disc 16, the superficies 14 of which is fitted and sealed to the inner face 7 of the housing 4 as a spherical segment-shaped surface with identical centre C. A front face of the piston disc 16 is marked with 17. Lateral faces 18 of the piston disc 16 are surfaces of revolution having common axis t_2 with the piston 3 the constituent of which is common with that of the inner lateral faces 9 of the housing 4. In this embodiment the constituent is straight section, the lateral faces 18 are flat surfaces.

The piston disc 16 has slots 19 receiving the blades 5, in which radial nests 20 are formed for motion equalizing devices 21. The geometrical axis of the radial nest 20 as surface of revolution passes through the centre C.

The motion equalizing device 21 is formed as rotary fork 22 (Figure 2). Outer revolution surface 24 of fork shanks 23 of the rotary fork 22 is fitted and sealed into the radial nest 20 of the piston disc 16 as to allow its swing; inner faces of the fork shanks 23, to bottom surface 26 and inner lateral faces 25 seal and surround the lateral faces 11 of the blade 5, and the bottom surface 26 is fitted and sealed to the inner end face 12 of the blade 5. The inner lateral faces 25 and the lateral faces 11 as well as the bottom surface 26 and inner end face 12 are identical geometrical surface-pairs. Front faces 27 of the fork shanks 23 are spherical segment-shaped surfaces with centre C fitted and sealed to the inner face 7 of the housing 4.

In the present embodiment two opposite blades 5 of identical medium plane are in the housing 4, which divide the interior 6 into four compartments 28. In operation the sealed lateral faces 18 of the piston disc 16 roll down and slide the inner lateral faces 9 of the housing 4.

In this embodiment the lateral faces 9 and 18 are in contact with each other. Each compartment 28 has at least two medium carrying channels 29 formed (inlet or outlet) in the side 8 of the housing 4 in the vicinity of the blades 5 (Figure 2). The channels 29 are interconnected with supply and discharge channels and control elements (not shown), the latter ones formed as simple snuffle valves.

The housing 4 has a power and motion transmission means which is provided with a gear rim 30. A superficies 31 and outer lateral faces 32 of the housing 4 are surfaces of revolution, axis t_1, thus the ball piston construction 1 is suitable for incorporation as rotor in the machine body provided with medium carrying channels connected to the channels 29 and control elements (not shown).

The piston core 13 of the piston 3 is provided with trunnion 33, which forms power and motion transmitting means with an oblique-bored shaft 34, in which the axis of a hole 35 receiving the trunnion 33 is at an angle α to the axis of rotation t_1 of the oblique-bored shaft 34.

The ball piston construction according to Figures 1 and 2 may be operated as pump, if the medium carrying channels (not shown) connected to the channels 29 of the housing 4 are provided with medium control elements, e.g. with snuffle valves. In this case the housing 4 is fixed against turn through its power transmission means such as the gear rim 30. The oblique-bored shaft 34 turned around the axis t_1 rotates the trunnion 33 that is bearing supported in hole 35, the axis of rotation of which t_2 — as the axis of the piston 3 revolves around a conical surface at half-angular subtense α. Meanwhile the piston 3 performs wobbling motion around the ball centre C, whereby the rotary fork 22 arranged in the radial nest 20 performs $\pm\alpha$ angular displacement relatively to the piston disc 16. On the other hand, the rotary fork 22 performs $\pm\alpha$ angular displacement around the ball centre C along the plane of the blade 5. Each constituent of the lateral faces 18 of the piston disc 16 are in contact with each constituent of the inner lateral faces 9, the surfaces rolling and sliding on each other. During the wobbling motion of the piston disc 16 the volume of each compartment 28 varies between 0 and the maximum value. Until the volume of the compartment 28 increases, it sucks in medium through the corresponding channel 29 according to the direction of rotation, then the volume of the compartment 28 decreases and the medium flows out through the corresponding channel 29.

Rotating operation is also realizable, since the superficies 31 and the lateral faces 32 of the housing 4 are surfaces of revolution, thus the housing 4 is suitable for building in as rotor into the stationary housing and for rotating it with driving mechanism through the gear rim 30. The medium carrying channels of the stationary housing (not shown) with the rotating channels 29 perform the control of the flow of medium. When the housing 4 is rotated, the wobbling motion of the piston 3 — as the required operation — is realized, provided that the oblique-bored shaft 34 is fixed against rotation, because in that case the trunnion 33 and the piston 3 rotate with the housing 4 around the axis of rotation t_2.

The second embodiment of the ball piston construction 1 with sealed constituent according to the invention shown in Figures 3 and 4 differs

from the construction according to Figures 1 and 2 in the number of the blades 5 and compartments 28, and in the construction of the motion equalizing device 21.

In this case the number of the blades 5 is four spaced at 90°. The motion equalizing device 21 has a rotary fork 22. The inner faces of fork shanks 23 of the rotary fork 22, so the bottom surface 26 and the inner lateral faces 25 are sealed and surround the lateral faces 11 of the blade 5, and the bottom surface 26 is sealed and fitted to the inner end face 12 of the blade 5. The inner lateral faces 25 and lateral faces 11 as well as bottom surface 26 and inner end face 12 are identical surface-pairs. The front faces 27 of fork shanks 23 of the rotary fork 22 are also spherical segment shaped surfaces with centre C, sealed and fitted to the inner face 7 of the housing 4. The outer revolution surface 24 of the fork shanks 23 is fitted and sealed — allowing rotation — into a radial nest of an excentric fork 36 formed in a slot 38 of the excentric fork 36. The radial nest is shaped as a revolution surface 37, its axis t_4 passes through the ball centre C. A bottom surface 39 of the slot 38 is a spherical segment-shaped surface with ball centre C fitted and sealed to the inner end face 12 of the blade 5. An outer revolution surface 41 of a fork shanks 40 of the excentric fork 36 is fitted into the radial nest 20 of the piston disc 16. The axis of the outer revolution surface 41 of the fork shanks 40 coincides with the axis t_3 of the radial nest 20 passing through the ball centre C. Front face 42 of the fork shanks 41 is a spherical segment-shaped surface with the ball centre C fitted and sealed to the inner face 7 of the housing 4.

The construction according to the second embodiment functions similarly to the one according to Figures 1 and 2, the difference is only in the operation of the motion equalizing device 21. Since the number of equally spaced blades 5 is four, thus during the relative wobbling motion not only the rotary fork 22 but the excentric fork 36 too rotates around their axes in relation to the piston 3, whereby the angle of axes t_4 of the two adjacent rotary forks 22 varies.

The third embodiment of the ball piston construction with sealed constituent according to the invention shown in Figures 5 and 6, differs from the one according to the second embodiment in the motion equalizing device 21.

The motion equalizing device 21 has also a rotary fork 22. The inner faces of the fork shanks 23 of rotary fork 22, so the bottom surface 26 and the inner lateral faces 24 are sealed and surround the lateral faces 11 of blade 5, and the bottom surface 26 is fitted and sealed to the inner end face 12 of the blade 5. The inner lateral faces 25 and lateral faces 11 as well as the bottom surface 26 and inner end face 12 are identical surface-pairs. The front faces 27 of the fork shanks 23 of the rotary fork 22 are spherical segment-shaped surfaces with centre C, sealed and fitted to the inner face 7 of the housing 4. The outer rotation surface 24 of the fork shanks 23 is fitted and sealed — allowing rotation — into a radial nest 44 of a flat fork 43, the axis t_3 of said nest passes through the ball centre C, perpendicular to the axis t_2 of the piston 3 and formed as surface of revolution. A front faces 46 of a fork shanks 45 of flat fork 44 are spherical segment-shaped surfaces with ball centre C, fitted and sealed to the inner face 7 of the housing 4. The fork shanks 45 have outer guide ribs 47 fitting into grooves 48 of the radial nest 20 of the piston disc 16. Lateral faces 49 of the grooves 48 are surfaces of revolution — flat surfaces in this example — the axis of which is identical with the axis t_2 of the piston disc 16. Lateral faces 50 of the identically formed outer guide ribs 47 are fitted and sealed to the flat surfaces of the grooves 48. The flat fork 43 is capable to turn around the axis t_2 of the piston disc 16 to a limited extent, the turn being limited by a contact surfaces 51 of the radial nest 20 and by an outer front faces 52 forming the counterfaces of the flat fork 43.

The construction according to Figures 5 and 6 functions similarly to the one given in the second embodiment, the difference is only in the motion equalizing device 21. In this case too the angle of the axis of the two adjacent rotary forks 22 varies during the relative wobbling motion of the piston 3, since the two adjacent flat forks 43 in which the rotary forks 22 are arranged approach or move off each other by turning around axis t_2 along the plane perpendicular to axis t_2 of the piston 3. Thus the outer guide ribs 42 of the fork shanks 45 of the flat fork 43 slide tangentially in the groove 48 of the radial nest 20 of the piston disc 3.

A further embodiment of the ball piston construction according to the invention shown in Figure 7 is formed as twin-pistoned power machine 53 with transfer port. The twin-pistoned power machine 53 has a housing structure 54, housing 55 and two blades 56 fixed in the housing 55. The interior 57 of the housing 55 is confined by spherical segment-shaped inner faces 58_A and 58_B adjoining each other and by inner lateral faces 60_A and 60_B of sides 59.

The distance between centres C_1 and C_2 of the inner faces 58_A and 58_B is less, than the length of diameter of the inner faces 58_A and 58_B, but greater than the distance given by the sum of the radii of superficies 63_A and 63_B of piston cores 62_A and 62_B of piston 61_A and 61_B. Axis t_5 of the housing 55 passes through centres C_1 and C_2. The inner lateral faces 60_A and 60_B are surfaces of revolution formed by the constituent turned around axis t_5 in this case are conical surfaces. The blades 56 fitted and sealed into the grooves 64 of the inner faces 60_A and 60_B, the superficies 58_A and 58_B. Axis t_5 of the housing 55 is in the medium plane of the blades 56. Lateral faces 67 of the blades 56 surrounding compartments 65 and 66 are surfaces of revolution — flat surfaces in this example — the axis of which is perpendicular to the axis t_5 of the housing 55 and to the medium plane of the blade 56.

The two identical pistons 61_A and 61_B are built into the housing 55. Each piston core 62_A or 62_B

of the piston 61_A or 61_B has spherical segment-shaped superficies 63_A or 63_B fitted into a spherical segment-shaped nest 68 of the sides 59 of the housing 55, the centres of which are C_1 and C_2. The piston core 62_A or 62_B of each piston 61_A or 61_B forms a single piece with a piston disc 69_A or 69_B superficies 70 of which is a spherical segment-shaped surface with centres C_1 and C_2 fitted and sealed into the inner face 59 of the housing 55. Lateral face 71_A or 71_B of each piston disc 69_A or 69_B facing the inner lateral face 60_A or 60_B is a surface of revolution, the axis of which is identical with axis t_6 of the piston 61_A or 61_B and its constituent is common with that of the inner lateral face 60_A or 60_B. In this example the constituent is straight, the lateral face 71_A or 71_B is conical surface, the bending angle is identical with that of the inner lateral face 60_A or 60_B. An other lateral face 72_A or 72_B of the piston disc 69_A or 69_B is formed similarly as a conical surface, its axis is identical with the axis t_6 of the piston 61_A or 61_B, the conical surface has straight constituent. The two pistons 61_A and 61_B are formed and arranged in the housing 55 in such a manner that the apexes of the lateral faces 72_A and 72_B coincide (in the centre C_3). The lateral faces 72_A and 72_B of the piston disc 69_A, 69_B respectively are provided with cylindrical parts 80_A, 80_B respectively.

Slots 73 receiving the blades 56 are in the piston discs 69_A and 69_B, in which radial nests 74 are formed for the motion equalizing devices 21. The axis t_7 of the radial nest 74 formed as surface of revolution passes through centre C_1. The motion equalizing device 21 is formed in this case as an excentric fork 76 and as the rotary fork 22 arranged within. The lower part of the radial nest 74 is a blind hole 75 machined in the piston core 62, its upper part is cylindrical surface 77 machined in piston disc 69_A or 69_B. Construction and function of the motion equalizing device 21 are the same as described in Figures 3 and 4.

The interior 57 of the housing 55 is divided into the compartments 65 and 66 by the blades 56 and the pistons 61_A and 61_B. The compartment 65 is formed between the inner lateral face 60 of the housing 55 and the lateral faces 71_A and 71_B of the pistons 61_A, 61_B. The actuating medium connection of the compartment 65 is formed as a port 78 on the side 59 of the housing 55, and the medium connection of the compartment 66 is formed as a port 79 leading to the superficies 58 of the housing 55.

The exterior of the housing 55 is formed the same way as in the first embodiment, both the housing 55 and the piston 61 have the same power and motion transmitting means.

The compartments 65 of the construction according to Figure 7 function the same way, as the compartments 28 in Figures 1 and 2.

Operation of the compartment 66 is determined by the joint relative wobbling motion of piston discs 69_A and 69_B of the two pistons 61_A and 61_B. Volume of said compartment varies between 0 and maximum value. Until the volume of the compartment increases, it sucks in the medium through the corresponding port 79 — depending on the direction of rotation — then the volume decreases and the medium flows out of the compartment 66 through the corresponding port 79.

The twin-pistoned power machine 53 similarly to the former embodiments can be operated in wobbling, rotary and combined operation modes.

In the annexed claims reference numbers have been used purely by way of example and aiding understanding but not of limitation of scope.

List of the Reference Numbers

1 ball piston construction
2 housing structure
3 piston
4 housing
5 blade
6 interior
7 spherical segment-shaped inner face
8 side
9 inner lateral face
10 groove
11 lateral face
12 inner face
13 piston core
14 spherical segment-shaped superficies
15 nest
16 piston disc
17 front face
18 lateral face
19 slot
20 radial nest
21 motion equalizing device
22 rotary fork
23 fork shank
24 outer revolution surface
25 inner lateral face
26 bottom surface
27 front face
28 compartment
29 channel
30 power and motion transmission means/gear rim
31 superficies
32 outer lateral face
33 trunnion
34 oblique-bored shaft
35 hole
36 excentric fork
37 revolution surface
38 slot
39 bottom surface
40 fork shank
41 outer revolution surface
42 front face
43 radial nest
44 flat fork
45 fork shank
46 front face
47 outer guide rib
48 groove
49 lateral face
50 lateral face

51 contact surface
52 outer front face
53 twin-pistoned power machine
54 housing structure
55 housing
56 blade
57 interior
58_A, 58_B inner faces
59 side
60_A, 60_B inner lateral faces
61_A, 61_B pistons
62_A, 62_B piston cores
63_A, 63_B superficies
64 groove
65 compartment
66 compartment
67 lateral faces
68 nest
69_A, 69_B piston disc
70_A, 70_B superficies
71_A, 71_B lateral face
72_A, 72_B lateral face
73 slot
74 radial nest
75 blind hole
76 excentric fork
77 cylindrical surface
78 port
79 port
80_A, 80_B cylindrical ports

CLAIMS

1. Ball piston construction for machines, e.g. machines or pumps, provided with compartment-confining elements in relative wobbling motion and with a medium-carrying channel, one of them formed as housing structure, the other one as a piston, or pistons, wherein the inerior of the housing is radially arranged and divided into compartments by fixed blades,

the interior of the housing is confined by at least one spherical segment-shaped inner face, the centre of which forms the centre of the housing and by a lateral face which is surface of revolution co-axial with axis (t_1, t_5) of said inner face,

a spherical segment-shaped nest is formed in the side of the housing, the centre of which is the same as the centre (C, C_1, C_2) of the inner face of the housing,

a lateral face of each blade confining the compartments is a surface of revolution, the axis of which is perpendicular to the axis (t_1, t_5) of the housing and to the median plane of the blades, an inner end face of each blade is a spherical segment fitting to a surface of a piston core of the piston,

the housing is provided with an external power-transmitting means, the surface of the piston core is a spherical segment having an identical centre (C, C_1, C_2) with and fitted and sealed to the spherical segment-shaped surface of the nest in the side of the housing and has power-transmitting means for external connection,

the piston has a piston disc the surface of which is a spherical segment fitted and sealed to inner face of the housing having a common centre (C, C_1, C_2),

the lateral faces of the blades confining the compartments are surfaces of revolution co-axial (t_2, t_6) with the piston; the piston disc has radial slots (19, 73) receiving the blades and in each said slot a radial nest is formed for a motion-equalizing device,

in said nest a fork-shaped motion-equalizing device is fitted and sealed through its surface allowing angular displacement around axis (t_3) perpendicular to axis (t_2) of the piston in the median plane of the blade; its inner faces are fitted and sealed to the lateral faces of the blades and the inner end face has identical geometrical surfaces with them,

the front faces of the fork shanks are fitted and sealed to the inner face of the housing,

furthermore at least one of the transmitting means of the housing and of the piston is formed so as to be suitable for motion transmission at the same time.

2. Ball piston construction as claimed in claim 1, wherein the medium-carrying channels leading into the compartments are formed as perforations in the wall of the housing, the surface of which is surface of revolution suitable for sealing, and the power-transmitting means (30) of the housing is formed to be suitable for motion transmission.

3. Ball piston construction as claimed in claim 1, wherein the housing has two opposite blades with the same median plane and its motion-equalizing device is formed as a rotary fork, the surface of the fork shanks are surfaces of revolution fitting into the radial nest formed as surface of revolution in the slot of the piston disc, the axis (t_3) of which passes through the centre (C) of the housing.

4. Ball piston construction as claimed in claim 2, wherein the rotary fork of the motion-equalizing device (21) is arranged in an eccentric fork; surfaces (41) of the fork shanks of the eccentric fork fit into the radial nest formed as surface of revolution in the slot of the piston disc, the axis (t_3) of the radial nest passes through the centre (C) of the housing, the front faces (42) of the fork shanks (40) are fitted and sealed to the inner face of the housing; the axis (t_3) of the radial nest — fitting to the spherical surface the centre of which is identical with that of the housing and to the surfaces of the fork shanks of the rotary fork — intersects the axis (t_4) of a nest in an eccentric fork in the centre (C) of the housing (4).

5. Ball piston construction as claimed in claim 2, wherein the rotary fork of the motion-equalizing device is arranged in a flat fork the fork shanks of which have external guide ribs fitting into grooves of the radial nest of the piston disc being rotatable around the axis (t_2) of the piston, having flat lateral faces suitably perpendicular to the axis (t_2) of the piston disc (16), and a front face (46) of the fork shanks as spherical surface having an identical centre (C) with the housing is fitted

and sealed to the inner face of the housing (4).

6. Ball piston construction as claimed in claim 1, wherein a jacket confining the interior of the housing is a spherical segment-shaped inner face suitably with an identical diameter, the distance between the centres (C_1, C_2) is less than the length of diameter of the inner face, but greater than the distance given by the sum of the radii of surfaces of the pistons (61) fitting each spherical segment-shaped surface.

7. Ball piston construction as claimed in claim 6, wherein an opposite arranged lateral faces of the piston disc of the pistons surround the compartment, the connection of the actuating medium in the housing is formed as perforation leading into the inner face.

8. Ball-piston construction for machines and machines incorporating such constructions, substantially as herein described with reference to and as shown in the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1983. Published by the Patent Office 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

DERWENT-ACC-NO: 1983-754926

DERWENT-WEEK: 198903

TITLE: Ball piston construction for nutating-disc machine has piston mounted obliquely on rotary shaft and having slotted elements engaging radial blades in housing

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PRIORITY-DATA: 1982DE-3206286 (February 22, 1982)

PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE
GB 2115490 A	September 7, 1983	EN
DE 3206286 A	September 8, 1983	DE
FR 2522371 A	September 2, 1983	FR
SE 8201218 A	September 26, 1983	SV
DE 3206286 C	May 22, 1986	DE
IT 1154487 B	January 21, 1987	IT

APPLICATION-DATA:

PUB-NO	APPL-DESCRIPTOR	APPL-NO	APPL-DATE
DE 3206286A	N/A	1982DE-3206286	February 22, 1982
DE 3206286C	N/A	1982DE-3206286	February 22, 1982

INT-CL-CURRENT:

TYPE	IPC DATE
CIPS	F01C3/02 20060101
CIPS	F01C3/06 20060101
CIPS	F01C9/00 20060101

ABSTRACTED-PUB-NO: GB 2115490 A

BASIC-ABSTRACT:

The ball piston construction is for a machine of the nutating-disc type that may be used as an engine or a pump. The construction includes an engine or a pump a piston (16) mounted obliquely on a rotary shaft (34). Relative to the shaft the piston can revolve about its own axis t2 while the shaft turns about its axis t1. Slotted elements (21) in the piston are disposed radially and engage slidingly with radial blades (28) fixed in a housing structure (2).

The housing has conic inner surfaces (9) and is either fixed or rotates with the shaft. Ports for the working fluid may be formed in the conic surfaces. Power-transmitting gear-teeth (30) may be attached to the housing structure. When the housing structure is fixed the piston revolves about its axis as it rotates with the shaft and nutates in the housing structure. The piston is fixed relative to the housing structure when the latter rotates with the shaft.

TITLE-TERMS: BALL PISTON CONSTRUCTION NUTATING DISC MACHINE MOUNT OBLIQUE ROTATING SHAFT SLOT ELEMENT ENGAGE RADIAL BLADE HOUSING

DERWENT-CLASS: Q51 Q55 Q56 Q65